Northeastern

Department of Civil and Environmental Engineering
400 Snell Engineering
360 Huntington Ave.
Boston, MA 02115

CIVE 7381 Transportation Demand
Problem Set #4
Due: Monday, October 28, 2024

Problem 1

The file *Boston_TAZ_Data.xlsx* (Canvas, under PS 4) contains data from more than 2,720 TAZs (traffic analysis zones) in the Boston Metropolitan area. For each zone you have data on the total number of HBW trips **attracted** in the zone, in addition to land use information related to the zone. You will use the data to develop, using linear regression, a model that predicts the trips/day attracted by the zone.

a) Briefly discuss the cause/effect relationships you think are relevant for modeling trip attractions.

b) Present relevant statistical summaries and descriptive statistics on the data provided. Check for the presence of outliers. Also detect any other issues with the data.

c) Experiment with different linear regression models that can predict the number of trips attracted in each zone. You can use any software you are familiar with (excel, R, python, SAS, etc.) Report the results of your best model. Explain your choice by evaluating and validating each model, based on various statistical tests discussed in class (coefficient of determination, t-statistics, F-statistic confidence interval). Also discuss and interpret the model specification and the impact of the various parameters. Use scatter plots and other visual tools to illustrate your model performance (e.g., scatter plots of actual vs model predicted values).

d) Do the data and model results support the relationships you propose in a)?

The data file contains the following variables that can be used for the specification of your model. Use the variables as is or transform them to capture the effects that you think are important.

ID: ID of each TAZ
HBW_a: number of home-based work trip attractions in the TAZ
Total_Emp: total employment
Srv_Emp: service employment
Ret_Emp: retail employment
Bas_Emp: basic employment
K12_Emp: K12 private and public school employment
Coll_Emp: College employment
HH: number of households in the TAZ

Problem 2

An initial (seed) trip matrix is available. The trip matrix is symmetric and shown below. The table also shows the total (target) number of trips produced or attracted in each zone for the future planning year.

From\To	Origin OD matrix 1	2	3	4	5	6	Target Row Total (Productions)
1	5	40	120	30	50	60	800
2		5	52	55	60	100	400
3			10	25	90	30	400
4				10	15	45	200
5					15	55	500
6						20	700
Target Column Total (Attractions)	200	600	400	300	1000	500	3000

a. Using the above seed trip matrix estimate the 6x6 trip matrix for the target year. Iterate until it converges to an F value (target/predicted for each zone productions and attractions) between 0.90 to 1.10 (but no more than 3 iterations). Keep track of each row's and column's factor. Report your results for two different approaches and compare the two outputs:

   i. Average factor
   ii. Biproportional fitting IPF)

b. The travel time between the various zones is given below. Find the matrix of basic friction values for each zonal pair, using an exponential friction function, $f(t_{ij}) = exp(\beta t_{ij})$, with parameter $\beta = -0.05$.

From\To	Travel Times (min) 1	2	3	4	5	6
1	10	25	37	40	40	50
2	25	10	52	35	30	40
3	37	52	10	55	40	50
4	40	35	55	10	25	37
5	40	30	40	25	10	25
6	50	40	50	37	25	10

c. With the final trip distribution (OD matrix) found in question a) part i) above, calculate the average travel time (HINT: it should be a weighted average).

d. Apply the gravity model **once** (no balancing) for different values of the parameter β (assuming the productions, attractions, travel times and friction function given earlier). Assume that β values vary from -0.02 to -0.12 in increments of 0.02. Plot the average trip time against the corresponding value of the parameter β. Comment on the relationship.

e. Assume that the planning authority has estimated that the true average trip time is 26 minutes. Based on the results from part d) above, choose the value of the parameter β that is the most appropriate.

Problem 3

A small area is divided into 6 zones. The travel times t_{ij} between the zones are given in the table below (the travel times are symmetric):

Zone	1	2	3	4	5	6
1		10	17	16	12	22
2			7	6	15	12
3				13	8	5
4					21	9
5						13
6						

The target productions and attractions for each zone are given below:

Zone	P's	A's
1	1000	100
2	1500	500
3	100	3000
4	200	500
5	1700	50
6	780	1130
Total	5280	5280

a. Find the friction factors for each OD pair assuming that the friction function is given by:

$$f(t_{ij}) = \frac{1}{t_{ij}^2}$$

b. Find the zone to zone trip flows using the gravity model. Use the iterative updating of attractions and repeated application of the gravity model (discussed in class) to find the target trip interchanges (do not use the bi-proportional method to balance the attractions and productions). Perform no more than 2 iterations. You may use the practical considerations discussed in class to approximate the **intrazonal** travel times.